Space Weather Technical Forecast

Issued on Wednesday, 11 October 2023 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares likely days 1 & 2 (11-12 Oct), a chance of M-class flares days 3 & 4 (13-14 Oct). Chance G1/Minor G2/Moderate Geomagnetic Storm intervals days 1 & 2. Slight chance of R1/Minor Solar Radiation Storm throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with two M-flares, the largest peaking M2.3 at 10/1217 UTC from AR3451 in the northwest. There are currently eleven sunspots on the visible disk. AR3451(Eai/Beta-Delta) remains the largest region on the disc with the delta spot on its main trailer region maintained. AR3460, near centre disk, maintains a relatively complex structure with a delta spot on its main trailing portion, though showing slight signs of recent decay. The final notable spot is the new region on the northeast limb. This appears to be a large spot, perhaps with some magnetic complexity, though is difficult to analyse. All other regions appear to be small and relatively simple at present. No Earth-directed CMEs have been detected. A large CME observable from 10/1030 UTC has been analysed as a far sided event and despite it's size it is unlikely to have an Earth directed component.

Solar Wind / Geomagnetic Activity: Solar winds as observed at L1 by ACE/DSCOVR have persisted at generally slow-ambient conditions, with no indication of CH57/- fast winds. The solar wind speed has shown a slight downwards trend from 360kms to around 300km/s. Density was well below average and continues to fall. Total interplanetary magnetic field (IMF) strength, Bt, was weak throughout. The north-south component, Bt, was weak and mostly positive before 10/1500 UTC and negative thereafter, ranging -2 nT to +5 nT. Phi angle was generally positive (away from the Sun). Geomagnetic activity has been Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was Background to Moderate. Associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The observation at 11/0000 UTC was 1.44e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely to continue initially with isolated M-flares. The risk may then reduce from 13 Oct as AR3451 departs the disc, although, returning regions during the period bring a potential further increase risk of M-flares. There is a very slight chance of an isolated X-flare throughout.

Solar Wind / Geomagnetic Activity: A CME associated with the C6.6 flare of AR3460 that left the Sun on 08/0339 UTC, is forecast to arrive at Earth late day 1 (11 Oct), or more likely early day 2 (12 Oct). No further Earth-directed CMEs have been observed. Slow wind conditions initially. Earth is likely to move into the fast wind from CH58/- anytime from early on day 1 (11 Oct), peaking at slightly elevated or elevated levels of 450-550 km/s and lasting until early on day 3 (13 Oct). Through day 3 and into day 4 (13-14 Oct) winds are anticipated to gradually ease towards background. Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected initially, this increasing to largely Unsettled to Active (Kp 3-4) through day 1 and into day 2 (11/12 Oct) with a chance of G1/Minor or G2/Moderate storm periods due to a coronal hole high speed stream and/or a combined CME impact. Activity easing to mainly Quiet (Kp 0-2) from Day 3 (13

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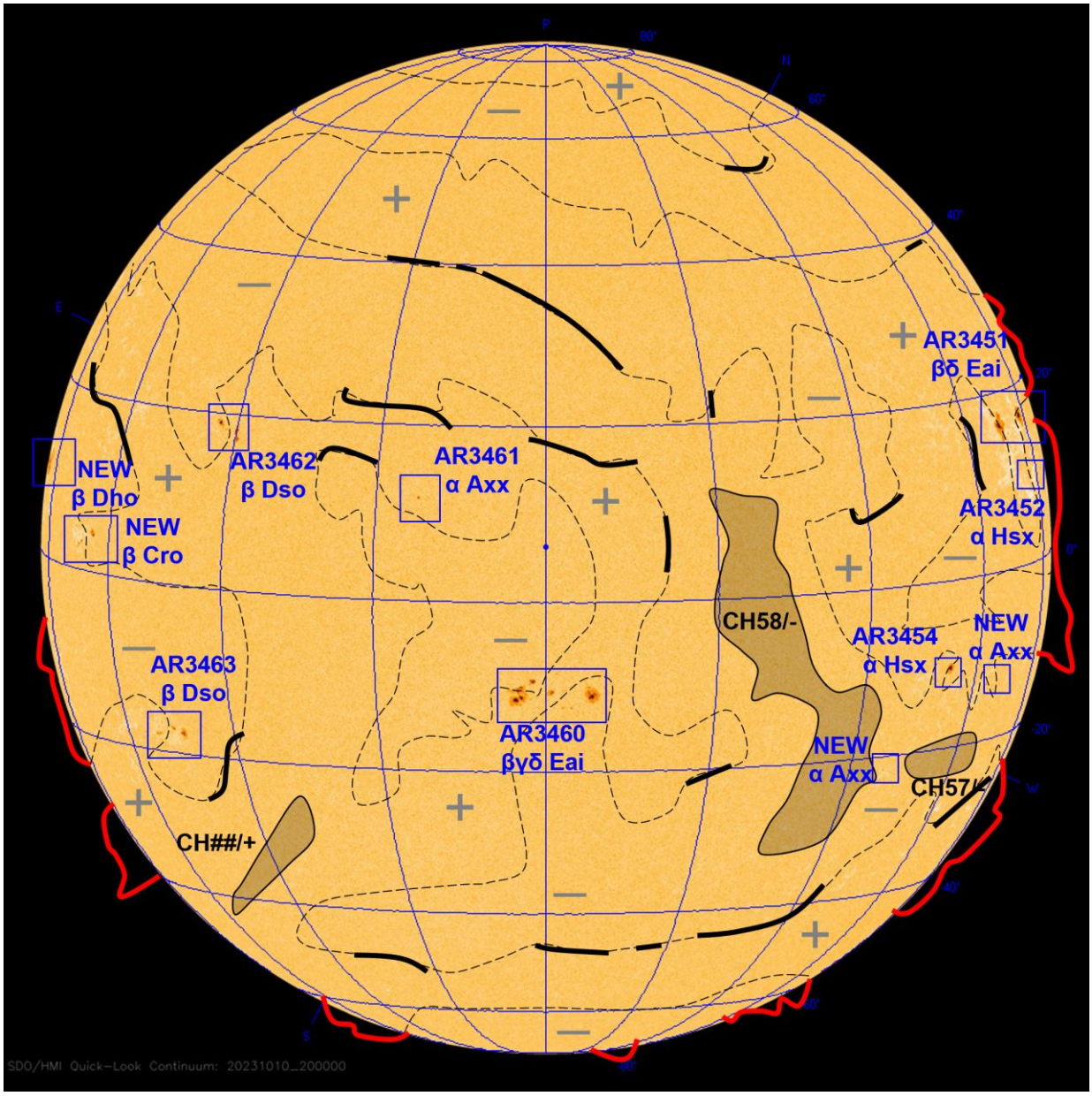
Oct).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at background levels, with a slight chance of enhancements to R1/Minor Solar Radiation Storm levels if any notable flares occur. High energy electron flux (greater than 2MeV) is forecast to remain largely at background to moderate levels, dropping out with any fast wind or CME arrivals before potentially increasing from Day 3 (13 Oct). Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

Figure 1. Solar Analysis Valid 10/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME associated with the C6.6 flare of AR3460 that left the Sun on 08/0339 UTC, is forecast to arrive at Earth late day 1 (11 Oct), or more likely early day 2 (12 Oct). No further Earth-directed CMEs have been observed.

Slow wind conditions initially, the fast wind of CH57/- is likely to have passed below Earth. Earth is still likely to move into the fast wind from CH58/- anytime from early on day 1 (11 Oct), peaking at slightly elevated or elevated levels of 450-550 km/s and lasting until early on day 3 (13 Oct). ENLIL is now thought to be overdone with timings and speeds of high speed streams, though SWPM is perhaps closer to the expected speeds of CH58/-. Through day 3 and into day 4 (13-14 Oct) winds are anticipated to gradually ease towards background.

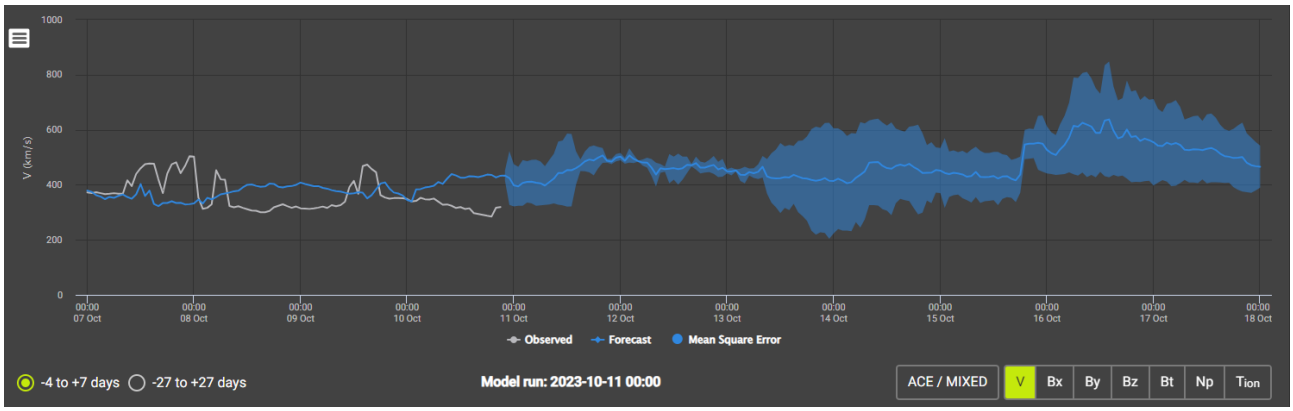
Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected initially, this increasing to largely Unsettled to Active (Kp 3-4) through day 1 and into day 2 (11/12 Oct) with a chance of G1/Minor or G2/Moderate storm periods due to a coronal hole high speed stream and/or a combined CME impact. Activity easing to mainly Quiet (Kp 0-2) from Day 3 (13 Oct).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	30	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
08/1435	Partial	AR3460	SE	460 km/s	Late 11/Early 12	Dependent of CH fast wind preceding

Figure 2: Latest SWPM



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Radio Blackouts - X-Ray Flares:

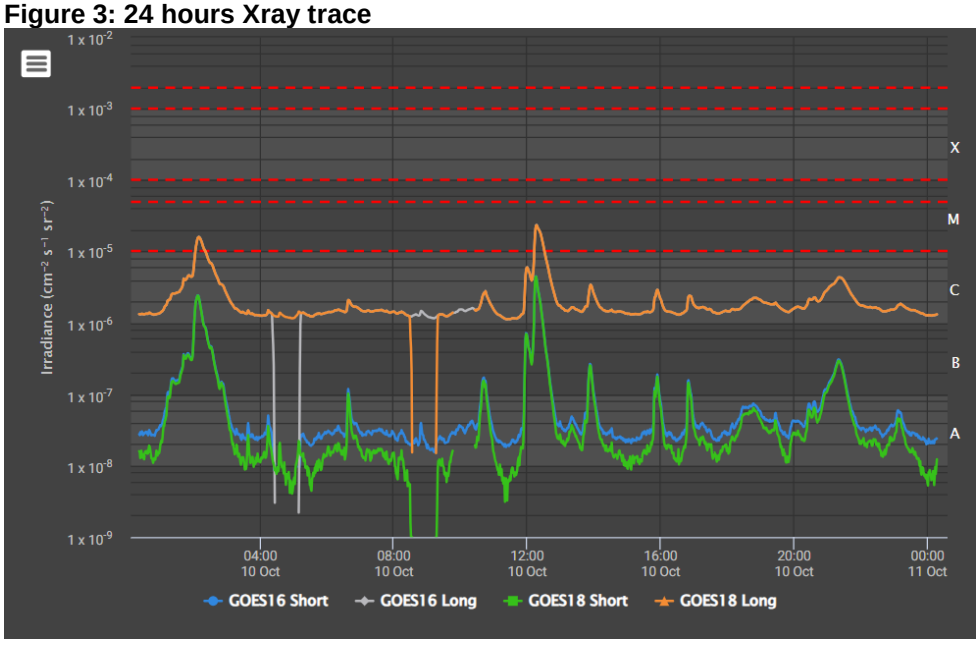
There are currently eleven sunspots on the visible disk. AR3451(Eai/Beta-Delta) remains the largest region on the disc with the delta spot on its main trailer region maintained. AR3460, near centre disk, maintains a relatively complex structure with a delta spot on its main trailing portion, though showing slight signs of recent decay. The final notable spot is the new region on the northeast limb. This appears to be a large spot, perhaps with some magnetic complexity, though is difficult to analyse at this point in time. All other regions appear to be small and relatively simple at present.

Moderate activity during the last 24 hours, with two M-class flares. Peak flare M2.3 at 10/1217 UTC from AR3451. Moderate activity is expected to continue, with further isolated M-flares considered likely. There is a slight chance of an isolated X-flare emanating from either AR3451, AR3460 or perhaps from the northeast limb.

Solar Activity is forecast to be Moderate with an ongoing risk of isolated M-class flares. M-flares are considered likely Days 1 & 2 (11/12 Oct) until AR3451 rotates around the northwest limb. The risk is expected to reduce slightly Day 3 Day 4 (13/14 Oct) though the returning regions in the northeast may yet alter this risk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hours Xray trace



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels. There are two spots currently with small delta spots, and given their locations, there is an increased potential for proton flux to rise should any notable flares occur. This risk decreases from day 3 (13 Oct) as AR3451 rotates around the northwest limb. A slight chance of S1/Minor Solar Radiation Storms is maintained throughout the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has peaked at moderate levels at the diurnal maximum in recent days, but is expected to continue at mainly background levels. Any fast wind arrival from CH58/- may act to initially supress observed values, alongside the potential CME arrival late Day 1 or Day 2 (11-12 Oct) but will see an increase in electron flux through the Van Allen Belts at lower orbits. This may lead to the observed flux at GEO increasing as solar wind pressure eases, bringing a chance of Moderate levels, perhaps peaking at High Day 3 onward (13-14 Oct).

Electron fluence is forecast to be well below the Active (1e8 integrated pfu) level throughout, however, albeit with an increasing trend from late Day 3 or Day 4 (13-14 Oct). MOSWOC REFM output is currently considered to be giving good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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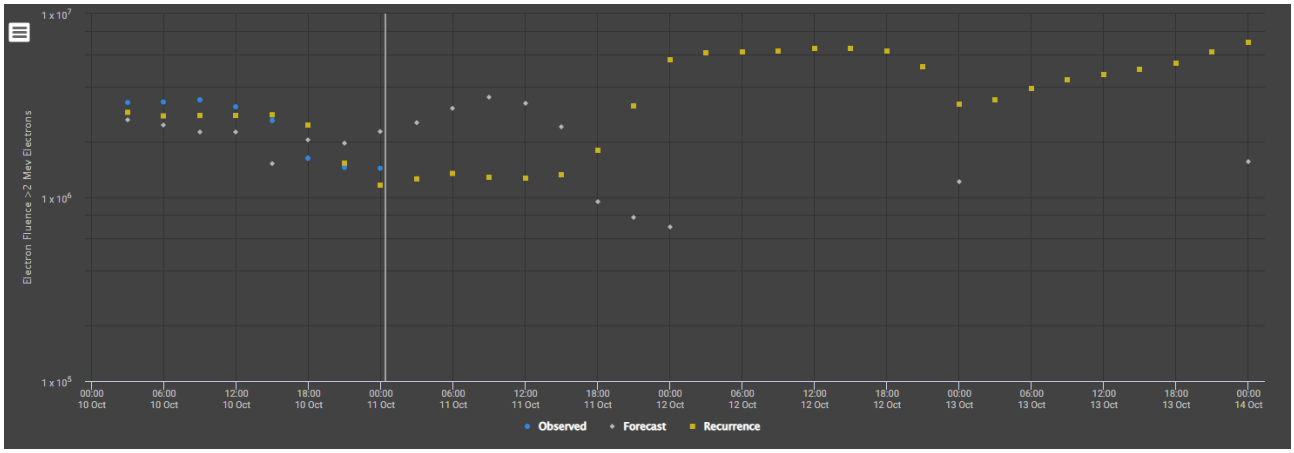
Figure 5: REFM



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